Advanced Electric Power Generation
Advanced Combustion/Heat Engines

Healy Clean Coal Project

Participant
Alaska Industrial Development and Export Authority

Additional Team Members
Golden Valley Electric Association—host and operator
Stone and Webster Engineering Corp.—engineer
TRW Inc., Space & Technology Division—combustor technology supplier
The Babcock & Wilcox Company (B&W) (which has acquired assets of Joy Environmental Technologies, Inc.)—spray dryer absorber technology supplier
Usibelli Coal Mine, Inc.—coal supplier

Location
Healy, Denali Borough, AK (adjacent to Healy Unit No. 1)

Technology
TRW's advanced entrained (slagging) combustor; Babcock & Wilcox's spray dryer absorber with sorbent recycle

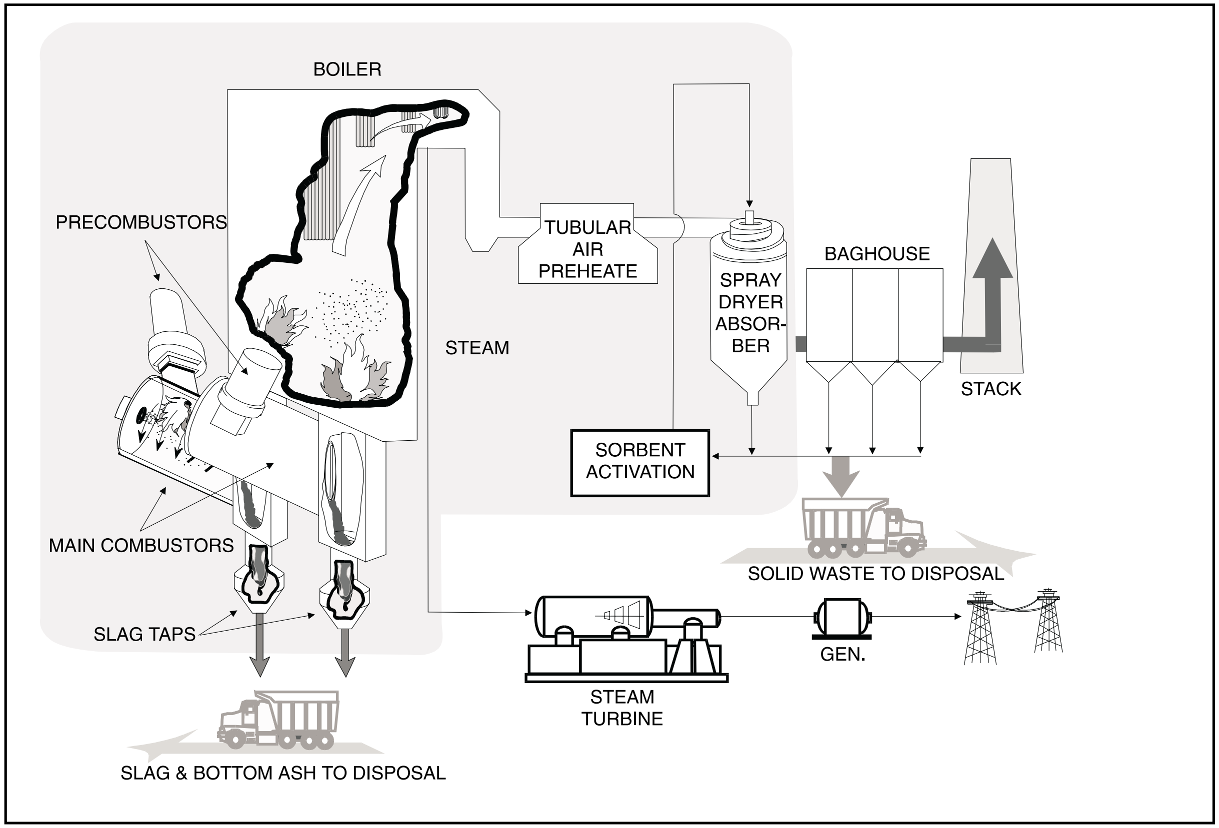
Plant Capacity/Production
50-MWe (nominal)

Coal
Usibelli subbituminous 50% run-of-mine (ROM) and 50% waste coal

Project Funding

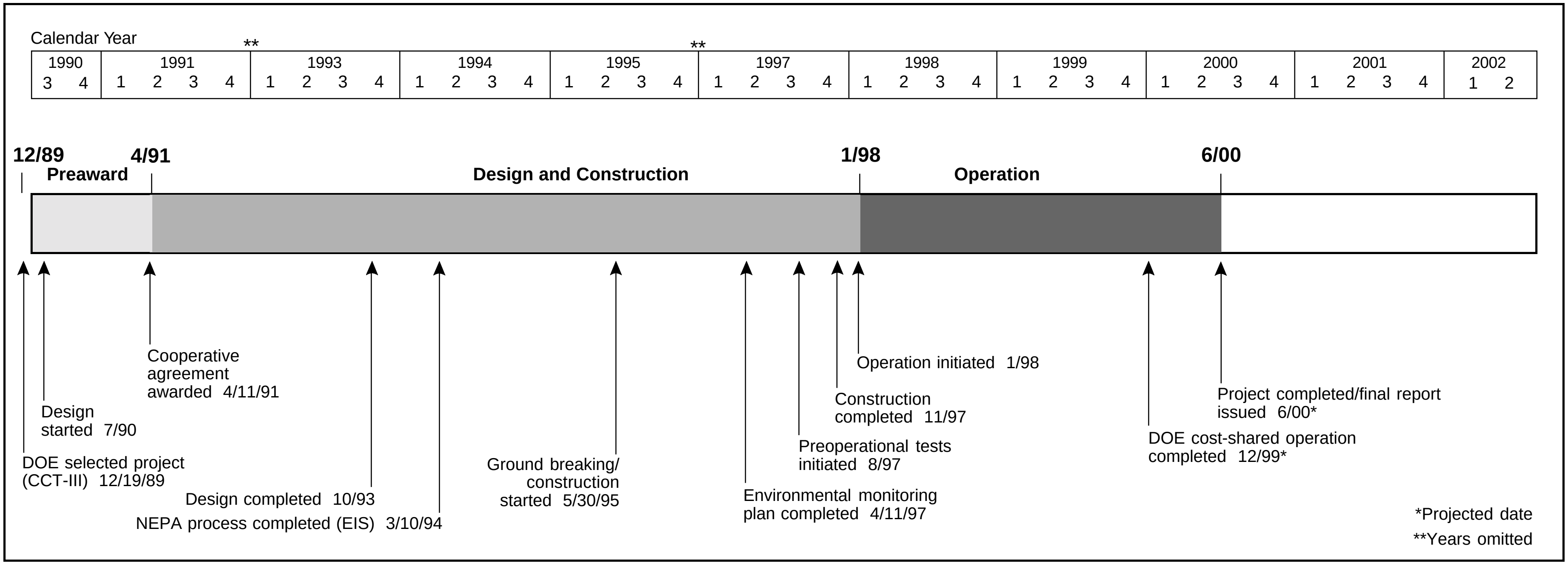
Total project cost	$242,058,000	100%
DOE	117,327,000	48
Participant	124,731,000	52

Project Objective
To demonstrate an innovative new power plant design featuring integration of an advanced combustor and heat recovery system coupled with both high- and low-temperature emissions control processes.



Technology/Project Description
The project involves two unique slagging combustors. Emissions of SO_2 and NO_x are controlled using TRW's slagging combustion systems with staged fuel and air and limestone injection for SO_2 control. Additional SO_2 is removed using B&W's activated recycle spray dryer absorber system.

A coal-fired precombustor increases the air inlet temperature for optimum slagging performance. The slagging combustors are side mounted, injecting the combustion products vertically into the boiler. The main slagging combustor consists of a water-cooled cylinder that slopes toward a slag opening. The precombustor burns 25–40% of the total coal input. The remaining coal is injected axially into the combustor, rapidly entrained by the swirling precombustor gases and additional air flow, and burned under substoichiometric conditions for NO_x control. The ash forms molten slag, which accumulates on the water-cooled walls and is driven by aerodynamic and gravitational forces through a slot into the slag recovery section. About 70–80% of the ash is removed as molten slag. The hot gas is then ducted to the furnace where, to ensure complete combustion, additional air is supplied from the tertiary air windbox to NO_x ports and to final overfire air ports. Pulverized limestone ($CaCO_3$) for SO_2 control is fed into the combustor where it is flash calcined (converting $CaCO_3$ to lime (CaO). The mixture of this CaO and ash not slagged, called flash-calcined material, is removed in the fabric filter system. Most of the flash-calcined material is used to form a 45% flash-calcined-material solids slurry. The SO_2 in the flue gas reacts with the slurry droplets as water is simultaneously evaporated. The SO_2 is further removed from the flue gas by reacting with the dry flash-calcined material on the



baghouse filter bags.

Project Status/Accomplishments

The project site is adjacent to the existing Healy Unit No. 1 near Healy, Alaska, and to the Usibelli coal mine. Power is supplied to the Golden Valley Electric Association (GVEA). The plant uses 900 tons/day of subbituminous and waste coal.

To address concerns about potential impact to the nearby Denali National Park and Preserve, DOE, the National Park Service, GVEA, and the project participant entered into an agreement to reduce emissions from Unit No. 1 so that combined emissions from the two units will be only slightly greater than those currently emitted from Unit No. 1 alone. Total site emissions will be further reduced to current levels if necessary to protect the park.

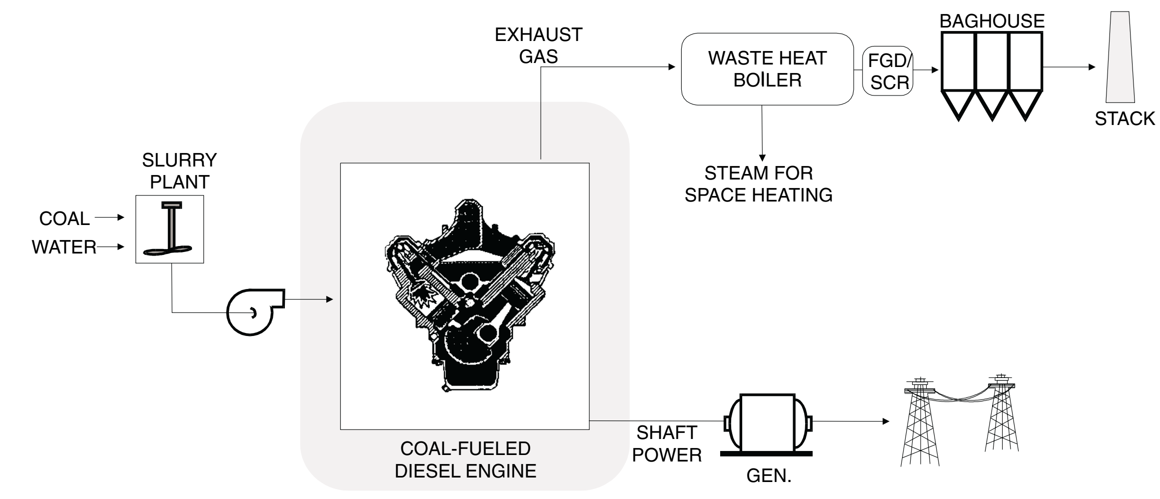
The initial firing of the entrained slagging combustion system on coal began in January 1998. The results from environmental compliance testing showed that NO_x emissions of 0.26 lb/10^6 Btu, SO_2 emissions of 0.01 lb/10^6 Btu, and particulate emissions of 0.0047lb/10^6 Btu were achieved. NO_x, SO_2, and particulate emission measures were within permit requirements. The permit requires NO_x emissions to be less than 0.35 lb/10^6 Btu, SO_2 emissions less than 0.086 lb/10^6 Btu, and particulate emissions less than 0.03 lb/10^6 Btu. The stringent SO_2 emission level required by the permit is significantly lower than the 1.2 lb/10^6 Btu NSPS limit.

The following modifications were made during a routine outage completed in January 1999: combustor improvements to minimize slag buildup in the precombustor/combustor, addition of an acoustical silencer to the ID fan area, and insertion of a flow distribution device prior to the baghouse to minimize bag wear. In addition, soot blowers were added in July 1999 to reduce furnace slag buildup around the combustor outlet. During a 90-day capacity factor test that began on August 17, 1999, the plant achieved an average capacity factor of over 90% through September 30, 1999. The test requirement is a capacity factor of 85%. Capacity factor testing and sustained operations testing will continue into December 1999.

Commercial Applications

This technology is appropriate for any size utility or industrial boiler in new and retrofit uses. It can be used in coal-fired boilers as well as in oil- and gas-fired boilers because of its high ash-removal capability. However, cyclone boilers may be the most amenable type to retrofit with the slagging combustor because of the limited supply of high-Btu, low-sulfur, low-ash-fusion-temperature coal that cyclone boilers require. The commercial availability of cost-effective and reliable systems for SO_2, NO_x, and particulate control is important to potential users planning new capacity, repowering, or retrofits to existing capacity in order to comply with CAAA requirements.

Clean Coal Diesel Demonstration Project



Participant
Arthur D. Little, Inc.

Additional Team Members
University of Alaska at Fairbanks—host and cofunder
Alaskan Science & Technology Foundation—cofunder
Coltec Industries Inc.—diesel engine technology vendor
Energy and Environmental Research Center, University of North Dakota (EERC)—fuel preparation technology vendor
R.W. Beck, Inc.—architect/engineer, designer, constructor
Usibelli Coal Mine, Inc.—coal supplier

Location
Fairbanks, AK (University of Alaska facility)

Technology
Coltec's coal-fueled diesel engine

Plant Capacity/Production
6.4-MWe (net)

Coal
Usibelli Alaskan subbituminous

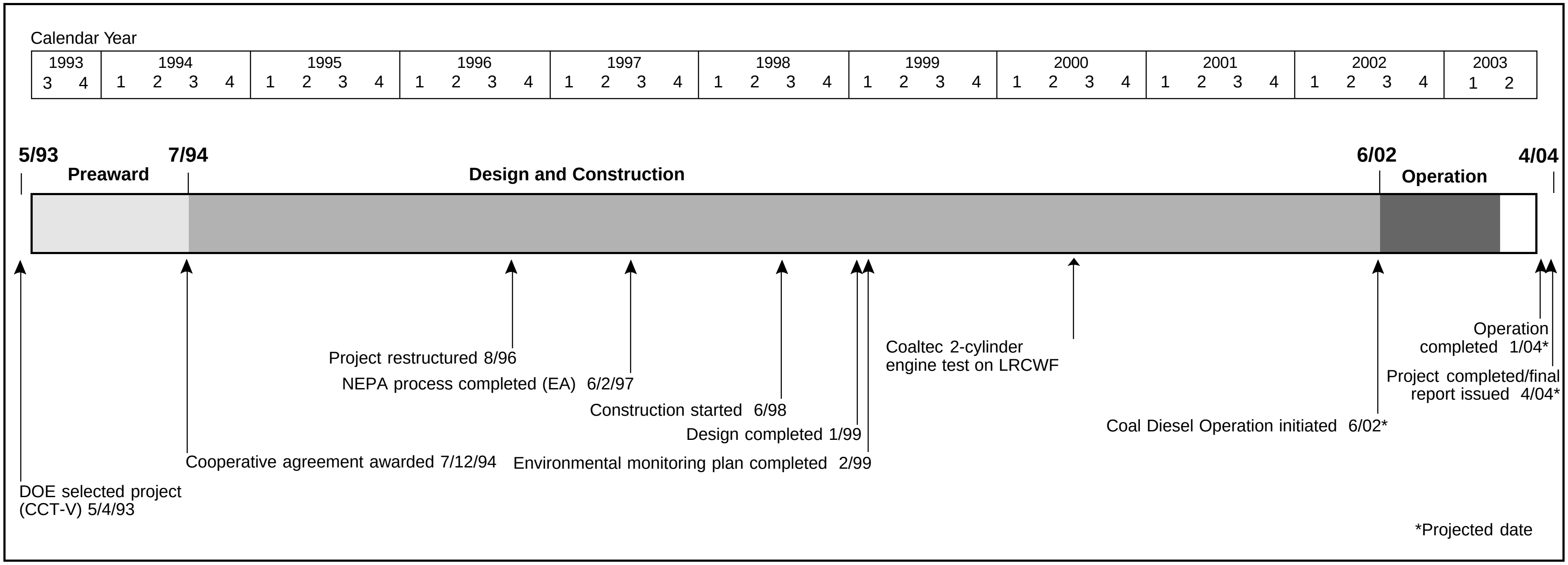
Project Funding

Total project cost	$47,636,000	100%
DOE	23,818,000	50
Participant	23,818,000	50

Project Objective
To prove the design, operability, and durability of the coal diesel engine during 6,000 hours of operation; verify the design and operation of an advanced drying/slurrying process for subbituminous Alaskan coals; and test the coal slurry in the diesel and a retrofitted oil-fired boiler.

Technology/Project Description
The project is based on the demonstration of an 18-cylinder, heavy duty engine (6.4-MWe) modified to operate on Alaskan subbituminous coal. The clean coal diesel technology, which uses a low-rank coal-water-fuel (LRCWF), is expected to have very low NO_x and SO_2 emission levels (50–70% below current New Source Performance Standards). In addition, the demonstration plant is expected to achieve 41% efficiency, while future plant designs are expected to reach 48% efficiency. This will result in a 25% reduction in CO_2 emissions compared to conventional coal-fired plants.

The LRCWF is prepared using an advanced coal drying process that allows dried coal to be slurried in water. In addition to the LRCWF being capable for use in the coal-fueled diesel engine, the LRCWF is expected to be an alternative to fuel oil in conventional oil-fired industrial boilers.



Project Status/Accomplishments

The project has passed several milestones. A 95% design review was conducted in January 1999 at the University of Alaska, Fairbanks (UAF). Representatives from Coltec, A.D. Little, UAF, DOE, and GHEMM (construction contractor) were in attendance. The latest design eliminates the need for a sorbent injection system because the Usibelli mine was able to locate a very clean coal seam with less than 0.2% sulfur in the ash. The sorbent injection system originally proposed for the coal diesel was designed for use with bituminous coals with greater than 2.0% sulfur levels. Coltec, the diesel engine manufacturer, worked with EERC to design new injectors with sapphire orifices sized for the volume of LRCWF required to operate the engine at full load. Earlier designs were based on higher energy density bituminous coals.

The 18-cylinder engine arrived in January 1999, but extremely cold weather prevented movement into the facilities building until the end of February 1999. The 18-cylinder diesel engine was operated on oil during September 1999. Prior to the 18-cylinder engine tests on coal slurry, Coltec will run their 2-cylinder test engine to optimize the operation settings, verify coal fuel performance, and finalize hard coatings for critical components. Tests are scheduled for May–September 2000.

Samples of the Usibelli coal were sent to CQ Inc., for washability tests; to ADL for wear tests; and to EERC for preliminary hot water drying tests and bench wear tests. Several plant design changes were made in order to keep the project within budget. Notably, a small commercial oil-fired boiler will be converted for coal slurry tests instead of an industrial-scale boiler, and several of the slurry holding tanks will be located closer to the diesel engine to reduce underground piping.

Final design of the LRCWF processing plant has been completed. Construction of the LRCWF has been delayed until May 2001 due to funding shortages. A revised plan and schedule for the demonstration test of the 18-cylinder diesel on coal slurry is being developed.

Commercial Applications

The U.S. diesel market is projected to exceed 60,000-MWe (over 7,000 engines) through 2020. The worldwide market is 70 times the U.S. market. The technology is particularly applicable to distributed power generation in the 5- to 20-MWe range, using indigenous coal in developing countries.

The net effective heat rate for the mature diesel system is expected to be 6,830 Btu/kWh (48%), which makes it very competitive with similarly sized coal- and fuel oil-fired installations. Environmental emissions from commercial diesel systems should be reduced to levels between 50% and 70% below NSPS. The estimated installation cost of a mature commercial unit is approximately $1,300/kW.